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Intellectual Property, Climate Change and Development

Dalindyebo Shabalala
University of Dayton, dshabalala1@udayton.edu

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Dalindyebo Shabalala*

Visiting Assistant Professor, Case Western Reserve University School of Law; Assistant Professor of International Economic Law (Intellectual Property), Faculty of Law, Maastricht University

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Introduction

Since the wave of independence that swept former European colonies in the middle to late twentieth century, access to technology and knowledge has been at the core of demands for restitution and aid by developing countries. The demands found their strongest expression in the Declaration on the Establishment of a New International Economic Order (NIEO) 1974[1] which sought, among other things:

> "Giving to the developing countries access to the achievements of modern science and technology, and promoting the transfer of technology and the creation of indigenous technology for the benefit of the developing countries in forms and in accordance with procedures which are suited to their economies."[2]

This demand for transfer of technology as a means of achieving development was central to the vision of the NIEO and was adamantly resisted by developed countries.[3] A core part of this demand was a restructuring of the international intellectual property framework, primarily at WIPO, to better provide access to technology and knowledge for developing countries. A modest success was achieved in the 1967 Stockholm Intellectual Property Conference in the inclusion of an appendix in to the Berne Convention for the Protection of Literary and Artistic Works 1886, but no such success was achieved for the Paris Convention for the Protection of Industrial Property 1883 or the other treaties operating under the WIPO umbrella. Developing countries reacted by resisting any new norm-setting at WIPO, and this may have contributed to the impasse that led developed countries to seek other venues. This impasse culminated in the inclusion of intellectual property into the Uruguay Round of Multilateral Trade Negotiations that led to the formation of the World Trade Organization and the entry into force of the Agreement on Trade-Related Aspects of Intellectual Property Rights 1994 (TRIPS Agreement). Intellectual property has been at the core of the "development" discourse since the middle of the twentieth century. Developing countries have believed that technology transfer was crucial to economic development and "modernisation" and very quickly identified intellectual property protection as a barrier to achieving access to the best available technologies. Developing countries argue that the international intellectual property system, and

* This article is adapted and updated from portions of Dalindyebo Shabalala, "Climate Change, Technology Transfer and Intellectual Property: Options for Action at the UNFCCC", PhD Thesis, Maastricht University, 2014, available at *https://dalishabalala.files.wordpress.com/2014/10/shabalala-climate-change-tech-transfer-and-ip.pdf* [Accessed November 1, 2016].

1 "Declaration on the Establishment of a New International Economic Order", May 1, 1974, U.N. Doc. A/RES/S-6/3201.

2 "Declaration on the Establishment of a New International Economic Order", 1974, art.4.

3 For more on the history, see Padmashree Gehl Sampath and Pedro Roffe, "Unpacking the International Technology Transfer Debate: Fifty Years and Beyond" (2012) International Centre for Trade and Sustainable Development, Issue Paper No.36.

specifically the TRIPS Agreement, unduly restricts their ability to take measures to encourage and enable technology transfer.[4]

This article argues that this historical pattern has not only leaked into the climate change discussions, but has also reached its apotheosis as a "development" issue in the climate change negotiations. The article is made up of two key parts that explain:

1) how intellectual property and technology transfer became environmental and climate issues; and
2) how the climate challenge (in scope and timing) of technologies is essentially a development challenge.

How intellectual property and technology transfer became environmental and climate issues

In the decades following norm-setting impasse at WIPO in the early 1970s, technology transfer provisions became the pivotal elements of the increasing number of multilateral environmental agreements (MEAs) that were concluded in the period following the 1972 UN Stockholm Conference on the Human Environment.[5]

An emerging pattern in MEAs was that significant global problems such as cross-border pollution by power plants creating acid rain, or ozone depletion, were intimately linked to historical and continuing production and consumption patterns by developed countries. Action to address these problems required developing countries to forgo production and consumption pathways from which developed countries had already benefited. Such patterns continuously raised issues of fairness, justice, equity and historical responsibility, issues that may have reached their apotheosis in the climate change negotiations.

One of the ways that developing countries sought to address the issue of adjustment costs and equity was to gain assurances that they would be assisted financially with any adjustment costs, and that they would be provided with the best available technologies, on grant or concessional terms, in making the adjustments required by the MEA. For example, there is strong evidence that India joined the Montreal Protocol on Substances That Deplete the Ozone Layer (Montreal Protocol) precisely on the understanding that alternative technologies would be made available on grant or concessional terms. At the time, the Multilateral Fund was replenished with this precise aim in mind.[6]

The demand for technology transfer has remained one of the strongest bargaining chips for convincing developing countries to participate in MEAs, but it has also remained the one that has been perceived to be the least fulfilled element of such MEAs, except for the notable exception of the Montreal Protocol. Developed countries' insistence on increased intellectual property protection has come to be seen by many developing countries as either emblematic of this failure, or the key reason why technology transfer has not occurred to any significant level.

The United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol are examples of this pattern. Developed countries took the greenhouse gas (GHG) emissions-intensive path to development. To convince developing countries to forgo such development, they had to promise significant financial support and access to technology. On one side, developed countries would take the first steps to reduce GHG emissions.[7] Under the Kyoto Protocol, they would move towards low-carbon or carbon-free economies, while they received credits for emissions they helped to reduce in developing

[4] South Centre, *Submission by the South Centre to the Technology Executive Committee (TEC) on Ways to Promote Enabling Environments and Address Barriers to Technology Development and Transfer and the Role of the TEC* (2012), p.6.

[5] "Report of the United Nations Conference on the Human Environment", June 5–16, 1972, A/CONF.48/14, para.2 and Corr.1.

[6] Veena Jha and Ulrich Hoffman (eds), *Achieving Objectives of Multilateral Environmental Agreements: A Package of Trade Measures and Positive Measures Elucidated by Results of Developing Country Case Studies* (Geneva: United Nations Conference on Trade and Development, 2000), pp.6, 35.

[7] United Nations Framework Convention on Climate Change 1992 art.4.

countries, through flexibility mechanisms such as the Clean Development Mechanism.[8] These and other mechanisms were meant to enable technology transfer to create endogenous capacity in developing countries to mitigate and adapt to climate change.[9] The effective implementation of these mechanisms has been an arena of contestation between developed and developing countries in the UNFCCC.

Intellectual property has been an issue since the very first UNFCCC Conference of the Parties (COP). In the first meeting of the Subsidiary Body on Scientific and Technological Advice in September 1995, China identified a need for renewable energy technologies as well as for the identification of adaptation technologies.[10] Access to technologies protected by intellectual property was raised almost immediately as a concern by the Alliance of Small Island States. Intellectual property became a larger part of the debate as developing countries came to believe that they were going to have to take unilateral action to achieve technology transfer. The technology transfer debate became particularly acute by the time of the 2007 Bali Conference. No agreement regarding intellectual property was reached at Bali. Negotiations on technology transfer were a major stumbling block and were among the last issues to be resolved.[11]

At COP 15 in Copenhagen in 2009, states reached no agreements on draft decisions on technology transfer that were put forward.[12] Those drafts contained bracketed language on intellectual property in para.6(f) on purchasing of licences and other intellectual property issues,[13] para.10(j) on the mandate of the technology mechanism to address intellectual property issues, and a whole section on intellectual property based on the G77 and Bolivia proposals. The COP decided to forward the draft decision into the Ad Hoc Working Group on Long-term Cooperative Action under the Convention in 2010 for further negotiations which resulted in the text being forwarded to the COP in Cancun. The 2010 negotiating text[14] reflects the importance of intellectual property to developing countries, both substantively and as a bargaining chip.

The Cancun Agreements flowing from COP 16 established a Green Climate Fund as an operating entity of the Convention and developed countries committed to providing US $100 billion per year by 2020 to meet the mitigation and adaptation needs of developing countries.[15] The Cancun Agreements also decided on the establishment of a Technology Mechanism consisting of a Technology Executive Committee and a Climate Technology Centre and Network. No mention of intellectual property remained in the text. The same pattern has repeated itself in the lead up to COP 17 in Durban in 2011[16] and COP 21 in Paris in 2015, at which the Paris Climate Change Agreement 2015 was signed. In the absence of greater financial support and active transfer of technologies, developing countries continue to seek changes in the intellectual property framework to facilitate unilateral action to transfer technology. In this sense, despite the consistent failure to address it in final agreements, intellectual property remains central to the outcomes that developing countries seek at the UNFCCC to enable an alternative, non-GHG emissions-intensive development path.

[8] Kyoto Protocol to the United Nations Framework Convention on Climate Change 1997 art.12.

[9] Kyoto Protocol to the United Nations Framework Convention on Climate Change 1997 art.10.

[10] International Institute for Sustainable Development, "Summary: 1st Session SBSTA & SBI", available at *http://www.iisd.ca/download/pdf/enb1223e.pdf* [Accessed November 1, 2016].

[11] International Institute for Sustainable Development, "Summary of the Thirteenth Conference of the Parties to the UN Framework Convention on Climate Change and Third Meeting of the Parties to the Kyoto Protocol", p.5, available at *http://www.iisd.ca/download/pdf/enb12354e.pdf* [Accessed November 1, 2016].

[12] "Draft decision -/CP.15. Enhanced Action on Technology Development and Transfer", February 5, 2010, U.N. Doc. FCCC/AWGLCA/2009/17, available at *http://unfccc.int/resource/docs/2009/awglca8/eng/17.pdf* [Accessed November 1, 2016].

[13] "Draft decision -/CP.15", 2010, para.6.

[14] "Negotiating Text", August 13, 2010, U.N. Doc. FCCC /AWGLCA/2010/14, p.46, available at *http://unfccc.int/resource/docs/2010/awglca12/eng/14.pdf* [Accessed November 1, 2016].

[15] "Decision 1/CP.16: The Cancun Agreements: Outcome of the Work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention", March 15, 2011, FCCC/CP/2010/7/Add.1, para.102.

[16] "Outcome of the Work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention to be Presented to the Conference of the Parties for Adoption at Its Seventeenth session—Draft Conclusions Proposed by the Chair", December 9, 2011, U.N. Doc. FCCC/AWGLCA/2011/L.4.

How the climate challenge becomes a development challenge

The Earth continues to experience record-breaking temperatures caused by increased atmospheric concentrations of carbon dioxide (CO_2) and other GHGs.[17] The impacts of this unprecedented warming include: increased floods and drought; rising sea levels; the spread of deadly diseases such as malaria and dengue fever; and increasing numbers of violent storms and weather-related catastrophes.[18] Climate change presents a challenge to almost all areas of human economic activity because of our reliance on GHG emitting fossil fuels and fossil fuel products, the key driver of global modernisation in the twentieth century.[19]

The most recent data suggests that the current emissions trajectory results in the high probability of 3.7°C of warming with catastrophic effect.[20] Factoring current pledges under the Paris Agreement still leaves a high probability of reaching 2.7°C. To keep warming well below 2°C, and to maintain the possibility of stabilising at the safe level of 1.5°C within reach, it may be necessary for global emissions to peak by 2020.[21] Projections based on past emissions suggest that the Earth is already locked into a baseline increase in temperature that makes some impacts unavoidable by 2100.[22] None of the associated costs of climate change between now and 2050 are likely to be avoided because of this lock-in. At the least, the available projections of necessary reductions suggest that a peak of emissions will have to take place by 2020, depending on the extent of cuts later in the lead-up to 2050.[23]

The challenge of adaptation is also quite clear, from sea-level rise to changes in the hydrological cycle leading to increased dryness in some areas and increased wetness in others. There is also a significant chance of shifts in geographical bands in which specific diseases and disease vectors proliferate.[24]

For adaptation, the first thing to note is the lock-in effect of 1°C warming by 2100 based on past emissions.[25] Such warming will have to be adapted to, and the slower the reduction in emissions, the quicker the 1°C threshold will be reached. The faster and more extensive GHG mitigation action takes place, the lower the likely cost of action to address adaptation will be.[26] Of course, the lower and slower the mitigation, the more adaptation that will be needed. However, due to the delay inherent in mitigating GHGs, temperatures are still likely to increase well into the middle of the twenty-first century even if all appropriate mitigation action is taken. Thus, the impacts that are already taking place and are projected to take place in the lead-up to 2050 will still need to be adapted to.[27] This entails increasing adaptive capacity in the near term by providing a means of sustainable development to a minimum level of per capita GDP to cope with existing climate variability and development challenges and then a focus on specific systems and tools to address specific climate impacts relevant to a region for the period after that. The Intergovernmental Panel on Climate Change (IPCC) analysis of timing of impacts and mitigation peaking dates suggests that much of the initial work for addressing vulnerability and resilience, even under the most optimistic scenarios, will have to be carried out almost immediately in order to be prepared to respond to impacts caused by the inevitable increase of temperatures to at least 1°C above pre-industrial levels that will occur up to 2050.[28]

[17] Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2014: Synthesis Report: Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2014), p.40 (core writing team: R.K. Pachauri and L.A. Meyer).

[18] IPCC, *Climate Change 2014* (2014), pp.50–53.

[19] David Stern and Custer J. Cleveland, "Energy and Economic Growth" (2004) Rensselaer Polytechnic Institute, Department of Economics, Working Paper in Economics No.0410, available at *http://www.economics.rpi.edu/workingpapers/rpi0410.pdf* [Accessed November 1, 2016].

[20] According to the Climate Action Tracker, available at *http://climateactiontracker.org/* [Accessed November 1, 2016].

[21] IPCC, *Climate Change 2014* (2014), p.82.

[22] IPCC, *Climate Change 2014* (2014), pp.78–79.

[23] IPCC, *Climate Change 2014* (2014); Paul Baer, Tom Athanasiou and Sivan Kartha, *The Right to Development in a Climate Constrained World* (Berlin: Heinrich Böll Foundation, 2007), p.15.

[24] IPCC, *Climate Change 2014* (2014), pp.64–73.

[25] IPCC, *Climate Change 2014* (2014), p.60.

[26] IPCC, *Climate Change 2014* (2014), p.67.

[27] Nicholas Stern, *The Economics of Climate Change: The Stern Review* (Cambridge: Cambridge University Press, 2007), p.284.

[28] IPCC, *Climate Change 2014* (2014), p.60.

For both mitigation and adaptation, the scenarios above have implications for the nature and scope of technology transfer and thus intellectual property. The first thing to note is that the peaking dates and climate impacts require the diffusion of existing technologies into the majority of developing countries within a very short period of time. For mitigation, the aim would be sometime between 2015 and 2018 but no later than 2020 of the best available technologies, both products and processes, that can be introduced and integrated into developing country economies. For adaptation, this means increasing the capacity to adapt in the lead-up to 2050, while ensuring the availability of current technologies for catastrophic climate events in the near term such as extreme weather events. The scope of technologies implied and the speed at which they need to be diffused therefore is vast.

In mitigation, several key short-term technology areas have been identified by scenarios at the IPCC, the International Energy Agency (IEA), as well as through Technology Needs Assessments from developing countries themselves.[29] These suggest that the following technological shifts will be needed.

- Electricity generation (almost entirely de-carbonised by 2050):
  - carbon capture and storage;
  - nuclear;
  - wind;
  - solar—concentrated solar power (CSP) and photovoltaic;
  - integrated gasification combined cycle combustion;
  - super-critical and ultra-supercritical coal;
  - hydro;
  - biomass and waste;
  - gas efficiency;
  - biofuels; and
  - smart electricity grids and networks (hard infrastructure and software).
- Industrial energy use efficiency and fuel switching:
  - iron and steel production (e.g. top gas recycling furnaces; highly reactive material additives to lower reducing agents; molten oxide electrolysis for iron production);
  - cement (e.g. substitutes for clinker additives);
  - chemicals and petrochemicals (e.g. improved catalytic processes; novel membrane technologies for separation processes; bio-based polymers to create new plastics);
  - paper (advanced water removal systems); and
  - aluminium (new inert and wetted cathode technologies; new methods for chemical reduction of kaolin).
- Building (construction and operation):
  - modern heat access (e.g. natural gas appliances, improved cook stoves (especially for biomass));
  - renewables for heat; and
  - thermal heat efficiency (e.g. combined heat and power, advanced building envelope seals and insulation).
- Appliances (appliances are a significant portion of global electricity end-use—a significant portion of end-use is in electric motors (found in most large appliances, compressors, fans, mechanical systems) at about 40 per cent of all global electricity end-use), e.g.:
  - dishwashers, clothes washers and clothes dryers;
  - lighting, including solar powered led lighting operating off-grid; and

[29] Stern, *The Economics of Climate Change* (2007); International Energy Agency (IEA), *Energy Technology Perspectives 2010: Scenarios and Strategies to 2050* (2010); IEA, *Energy Technology Perspectives 2012: Pathways to a Clean Energy System* (2012); IEA, *Tracking Clean Energy Progress: Energy Technology Perspectives 2012 Excerpt as IEA Input to the Clean Energy Ministerial* (2012).

— software and hardware, especially for managing active and standby power.

- Transport, e.g.:
  - — hydrogen fuel cells;
  - — plug-in hybrids and electric vehicles (PHEVs);
  - — batteries and storage;
  - — biodiesel and biofuels; and
  - — fuel efficiency of petrol or diesel vehicles.
- Agriculture, e.g.:
  - — plant varieties that are less reliant on GHG emissions-intensive fertilizers;
  - — animal variants and breeds less likely to produce methane during digestion; and
  - — better management of animal waste, including recycling into biogas and other biomass for energy generation.

In discussing the scope of action and technologies needed for the 2°C scenarios, one basic principle seems to apply: that no single technology or small subset of technologies will be sufficient. Policy will have to be brought to bear on all the identified technology sectors to achieve mitigation goals.[30] Given the longer-term challenge, existing technologies may be insufficient to meet the targets and that R&D will be required to reach 41–72 per cent reduction target by 2050.[31] This will require immediate and large-scale investments in R&D.[32] This confirms some of the earlier work done by *The Stern Review*, which argued that since no one technology is capable of providing the reductions needed, the development, deployment, diffusion of a broad portfolio of technologies is required.[33]

The need to essentially transform the energy production system targets one of the most crucial aspects of development, in terms of economic growth. The most basic and most important input into economic growth is energy. Thus, keeping the cost of energy production, distribution and consumption as low as possible is crucial to enable such growth in developing countries.[34] At present, access to electricity is limited to 20 per cent of the global population and approximately 15 per cent have only intermittent access.[35] Without a transformation in electricity production, almost all of that increase in developing countries is likely to come from coal-powered electricity generation. In 2008, developing countries produced over 70 per cent of electricity from fossil fuels, with coal at 46 per cent.[36] Thus use of renewable and sustainable energy is a fundamental element of addressing adaptation and development in developing countries.[37] It requires access to the full suite of best available technologies in energy production and consumption and will transform the entire energy use chain in developing countries. This makes energy access not just a development challenge, but one that is fundamentally the same as the climate challenge for developing countries.

Adaptation capacity is unevenly distributed, both across and within societies. This is co-extensive with uneven distributions of capacity to produce food, provide for health and create economic surpluses that can be reinvested in hard and soft infrastructure.[38] The majority of people in developing countries live in

[30] IEA, *Energy Technology Perspectives 2012* (2012), p.39.
[31] IPCC, *Climate Change 2014* (2014), p.82.
[32] IEA, *Energy Technology Perspectives 2012* (2012), p.56.
[33] Stern, *The Economics of Climate Change* (2007), p.211.
[34] UNEP, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication* (2011), p.208. See also Shardul Agrawala (ed.), *Bridge over Troubled Waters: Linking Climate Change and Development* (Paris: Organisation for Economic Co-operation and Development, 2005); Shardul Agrawala and Samuel Fankhauser, *Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments* (Paris: Organisation for Economic Co-operation and Development, 2008).
[35] IEA, *Advantage Energy: Emerging Economies, Developing Countries and the Private-Public Sector Interface* (2001), p.27, available at *https://www.iea.org/publications/freepublications/publication/advantage_energy.pdf* [Accessed November 1, 2016].
[36] IEA, *Advantage Energy* (2001), p.33.
[37] Global Network on Energy for Sustainable Development, *Reaching the Millennium Development Goals and Beyond—Access to Modern Forms of Energy as a Prerequisite* (2007).
[38] Global Network on Energy for Sustainable Development, *Reaching the Millennium Development Goals and Beyond* (2007).

climate-vulnerable environments and ecosystems.[39] Technology and innovative capacity are clearly co-extensive with adaptive capacity.[40] Increased technological capacity can decrease vulnerability by enabling deployment and use of relevant technologies and enable the development of new technologies to address the specific challenges of adapting to climate change impacts.[41]

One of the most important interventions that can be made in these developing countries to reduce vulnerability, while laying the groundwork for increasing adaptive capacity, are ones that increase economic growth as quickly and in as sustainable and equitable a manner as possible.[42] As a focus for the areas necessary to reduce such vulnerability, *The Stern Review* suggested that the key areas are:

- economic wealth;
- infrastructure and technology;
- information knowledge and skills;
- equity; and
- social capital.[43]

Infrastructure, technology, information, knowledge and skills are precisely those areas that can be best addressed by ensuring technology transfer. Developing countries are also significantly dependent on agriculture for economic growth (up to 64 per cent participation in South Asia and sub-Saharan Africa). They are thus more sensitive to climate variability.[44] A stable and sustainably growing framework for agricultural production and distribution is a necessity for reducing vulnerability and enabling adaptive capacity in developing countries.[45] Health interventions to deal with chronic diseases, both communicable and non-communicable, in developing countries are also a necessity to reduce vulnerability and adaptive capacity.[46] This implicates not only general health infrastructure and health management systems, but also the opportunity costs associated with prices of medical products, devices and services.

In essence, adaptation really addresses two core issues: reduction of vulnerability and increasing capacity to adapt. The overlap with poverty reduction strategies and other core development frameworks is significant. This means that the adaptation challenge is essentially a development challenge[47] and thus covers *all* sectors of technology relevant to ensuring rapid, non-fossil fuel dependent economic development. This implies not only a continuation of existing best practices[48] on ensuring transfer of technology, but also ramping up and introducing policies to speed up the process of development focused on technological transformation at an unprecedented speed and scale.

The implications of the framework for adaptation, especially to ensure adaptive capacity, suggest a far broader range of technologies and economy-wide action in developing countries that goes beyond simply energy. In addition, the time frames suggest actions must take place almost immediately to have an effect in the lead-up to 2050. Any solutions to reduce vulnerability and address adaptive capacity for developing countries must ensure access to the best environmentally sustainable technologies for:

[39] Agrawala (ed.), *Bridge over Troubled Waters* (2005); UNEP, *Towards a Green Economy* (2011), p.19; Gordon McGranahan, Deborah Balk and Bridget Anderson, "The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones" (2007) 19 Env't & Urbanization 17.

[40] W.N. Adger, S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, "Assessment of Adaptation Practices, Options, Constraints and Capacity" in *Climate Change 2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge: Cambridge University Press, 2007), p.728.

[41] Agrawala and Fankhauser, *Economic Aspects of Adaptation to Climate Change* (2008).

[42] World Bank, *World Development Report 2010: Development and Climate Change* (2010), p.12. See also Baer, Athanasiou and Kartha, *The Right to Development in a Climate Constrained World* (2007); Stern, The Economics of Climate Change (2007), p.12; UNEP, *Towards a Green Economy* (2011).

[43] Stern, *The Economics of Climate Change* (2007), p.94.

[44] UNEP, *Towards a Green Economy* (2011), p.38. See also Stern, *The Economics of Climate Change* (2007), p.95.

[45] UNEP, *Towards a Green Economy* (2011), pp.38–40.

[46] UNEP, *Towards a Green Economy* (2011), pp.208–209.

[47] Stern, *The Economics of Climate Change* (2007), p.430. See also Agrawala (ed.), *Bridge over Troubled Waters* (2005).

[48] Stern, *The Economics of Climate Change* (2007), p.432.

- energy production, distribution and consumption;
- agricultural inputs, including seeds (e.g. flood and drought resilient varieties), low emissions fertilizers, and methods and processes;
- health infrastructure, including medicines, diagnostic and treatment tools; and
- water infrastructure for capture, treatment, distribution and recycling.

Thus the adaptation challenge is a bifurcated development challenge: the specific need to ensure near-term adaptation in agriculture, health, water as well as disaster preparedness while building longer-term economic growth to prepare for the deeper impacts in the post-2050 period. The climate adaptation challenge, much as in mitigation, essentially collapses into the development challenge that developing countries have faced since the middle of the twentieth century.

The urgency of the climate or development challenge seems to bring us back full circle to the broader arguments about what role intellectual property has in encouraging technology transfer. While this seems to suggest that we have no option but to fall back on the same, tired old arguments, I argue that the structure of the climate challenge leaves few options but to truly transform the system for technology generation and diffusion if we are to meet mitigation and adaptation goals. The scale of technologies required, combined with the need to ensure distribution of those technologies within an extremely short time frame, means that business as usual in the intellectual property framework is not a tenable position. This is true even where it can be argued that significant portions of the technologies implicated are not patented in middle-income and least developing countries, because they are patented in key developing countries such as China and India, which serve as key developers, adapters and distributors of technologies to smaller developing countries.[49]

This presents a very different structural challenge for the international intellectual property system than the traditional development frame. Whereas in traditional development discourse developed countries have been able to argue that, over time, investment-friendly measures and higher intellectual property protection are the best way for developing countries to ensure that firms are willing to sell products and licence into their markets, climate change turns such arguments on their head. There is no more “time”.

For the distribution of existing mitigation technologies within the 2015–2018 time frame to enable peaking by 2020 at the latest, it seems inappropriate to rely on the relatively slow-moving process of existing trade and licensing patterns to encourage transactions and technology diffusion. It will require deliberate policies to encourage massive diffusion in the near term that both increase supply and demand for technologies.[50] For adaptation, especially in human health and agriculture, given the near-term impacts of climate change and extreme weather events, the need to diffuse technologies as quickly as possible to underpin economic development also suggests that a wholesale restructuring of technology markets will be needed.

The other side of the argument is that, in the absence of significant breakthrough technologies in areas such as battery storage, the longer-term challenge of mitigation in the post-2050 period is unlikely to be

[49] John Barton, “Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar Photovoltaic, Biofuel and Wind Technologies” (2007) Trade and Sustainable Energy Series, Issue Paper No.2. See also Copenhagen Economics and the IPR Company, “Are IPRs a Barrier to the Transfer of Climate Change Technology?”, available at *http://trade.ec.europa.eu/doclib/docs/2009/february/tradoc_142371.pdf* [Accessed November 1, 2016]; Antoine Dechezleprêtre, Matthieu Glachant, Ivan Haščič, Nick Johnstone and Yann Ménière, “Invention and Transfer of Climate Change-Mitigation Technologies: A Global Analysis” (2011) 5 Rev. Envtl. Econ. Pol’y 109; Ivan Haščič, Nick Johnstone, Fleur Watson and Christopher Kaminker, “Climate Policy and Technological Innovation and Transfer: An Overview of Trends and Recent Empirical Results” (2010) Organisation for Economic Co-operation and Development, Environment Working Paper No.30; Meir Perez Pugatch, “The Role of Intellectual Property Rights in the Transfer of Environmentally Sound Technologies” (2011); Kristina M. Lybecker and Sebastian Lohse, *Global Challenges Report* (Geneva: WIPO, 2015); UN Environment Programme, European Patent Office and International Centre for Trade and Sustainable Development, *Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final report* (2010); Bernice Lee, Ilian Iliev and Felix Preston, *Who Owns Our Low Carbon Future: Intellectual Property and Energy Technologies* (London: Chatham House, 2009).

[50] Christian Egenhofer, Lew Milford, Noriko Fujiwara, Thomas L. Brewer, Monica Alessi, *Low-Carbon Technologies in the Post-Bali Period: Accelerating Their Development and Deployment* (Brussels: European Climate Platform, 2007), p.3.

met.[51] The need to provide dynamic incentives for the generation of such technologies is thus also very significant. It will be crucial to provide incentives for innovation in a broad portfolio of technologies, especially those with significant network and public goods characteristics. While a significant chunk of incremental innovation can come from the private sector, the risk premium and investment analysis for breakthrough innovation may require significant and co-ordinated public funding to create many Manhattan project-like research paths in multiple sectors.[52]

A fundamental restructuring of international technology markets, including intellectual property rules, is clearly implied by this article's understanding of the climate challenge. However, any structural reform of the international intellectual property system to address climate change will have to differentiate in terms of intellectual property action and time frames between existing technologies and those to be developed and implemented in the post-2050 period.

A response to the argument that I have laid out about the need for fundamental restructuring of the international intellectual property system is that, given enough money, the problem of intellectual property costs will disappear and nothing structural will have to change in the system. That argument runs into a major problem: there may not be enough funding from developed countries to make technology access a reality for developing countries. The extent of public funding available, in particular, may not be anything close to what is actually required to address the full scope of action needed to develop, deploy and diffuse technologies. Looking just at mitigation scenarios, the IEA projected that from 2010 to 2020, over US $2.3 trillion annually would be needed to be invested, the majority of which was private flows.[53] The share of developing countries was US $1.3 trillion annually, of which China represented US $500 billion. In contrast to the scale of the projected need, total investment flows in 2010 and 2011 were US $247 billion and US $260 billion, respectively.

Within the climate change negotiations, developed countries in Copenhagen at COP 15 committed to provide US $100 billion annually by 2020 in investment (from a wide variety of sources, including public funds).[54] A significant portion is meant to flow through the Green Climate Fund (GCF), which implies direct cash or other instruments under the control of the fund, rather than financial instruments operating outside of the remit of the GCF. The IEA estimated in 2012 that climate mitigation-related flows from developed to developing countries amounted to somewhere between US $70 and US $199 billion per year.[55] The majority of this consisted of private flows (US $37–72 billion), and the public funds (through bilateral and multilateral mechanisms) amounted to a potential maximum of US $43 billion. Olbrisch, Haites, Savage, Dadhich and Shrivastava reviewed the range of estimates for incremental investment in the literature noting significant variations for 2030 projections for annual financing needs in developing countries: from US $177 to US $565 billion per annum.[56] They did not provide estimates of the portion that would be from private flows, but their estimate of current funding at the time suggested that private flows would be the largest proportion of funding amounting to at least US $65 billion per year.

Thus, in terms of direct support, it is unlikely that existing and future public funds will suffice to meet the need in developing countries.[57] As the IEA notes, they will have to also mobilise a significant amount of finance domestically.[58] This is all before funding for adaptation is taken into account, which under the GCF should take up half of the planned disbursements. The IEA and others have difficulty finding an

[51] M.I. Hoffert, Ken Caldeira, Gregory Benford, "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet" (2002) 298 Sci. 981. See also Egenhofer, Milford, Fujiwara, Brewer, Alessi, *Low-Carbon Technologies in the Post-Bali Period* (2007), p.1.

[52] UNEP, *Towards a Green Economy* (2011), p.233.

[53] IEA, *Energy Technology Perspectives 2012* (2012), p.139, Table 4.3.

[54] B. Childs Staley and Casey Freeman, "Tick Tech Tick Tech: Coming to Agreement on Technology in the Countdown to Copenhagen" (2009) World Resources Institute, Working Paper, p.13.

[55] IEA, *Energy Technology Perspectives 2012* (2012), p.152.

[56] Susanne Olbrisch, Erik Haites, Matthew Savage, Pradeep Dadhich and Manish Kumar Shrivastava, "Estimates of Incremental Investment for and Cost of Mitigation Measures in Developing Countries" (2011) 11 Climate Pol'y 970, 974.

[57] A. Bowen, "Raising Climate Finance to Support Developing Country Action: Some Economic Considerations" (2011) 11 Climate Pol'y 1020.

[58] IEA, *Energy Technology Perspectives 2012* (2012), p.152.

argument that investment flows for climate will differ in any significant way from existing patterns of investment into developing countries.[59] The prescriptions for providing a proper enabling environment replicate the same tried and true axioms of:

- reducing regulatory uncertainty;
- enabling policies for competitive, open markets and greening infrastructure investment;
- sound investment policies: market-based and regulatory policies to "put a price on carbon" and correct for environmental externalities;
- removing barriers and disincentives for innovation and investment; and
- financial policies and instruments to attract private sector participation.

However, these axioms can be applied specifically to climate change sectors. Other than a broader faith that these interventions will work, there is no little analysis of how these recommendations, as a broader matter, will shift the risk and investment calculus in economies that are not already attractive investment destinations—for domestic, but primarily foreign capital.

While attractive regulatory and market environments are clearly necessary conditions, they may not be sufficient to mobilise foreign investment at the scale required in markets that simply do not present a sufficient rate of return and may present, even at their best, more risk than the potential worth of returns. The policy prescription here essentially tells developing countries to transform their economies as a necessary condition for being able to transform their economies, without any of the necessary financial and technological support for doing so. These policy transformations are meant to substitute for financial support, and, hopefully, make it possible for private sector money to flow. How that presents a different, new or additional solution to the broader development challenge is not explained. In order to develop, developing countries must therefore "develop". Where they do so, this will obviate the need for significant public money and support.

In the end, the vast majority of financing and transfer will have to come from private sector action. Developed countries hope that the public finance shortfall will somehow be made up by private sector actors, as long as markets are created and regulatory incentives are put in place. However, where there is insufficient public finance to provide support to developing country actors and firms in accessing technology hardware and knowledge, a reliance on private finance leaves the additional costs of accessing knowledge in the hands of developing country firms and institutions. The only way therefore for developing countries to respond is to take regulatory action to restructure the market in knowledge and knowledge products so that the costs of action are borne by developed country actors. Such action leads us back to the government interventions aimed at regulating prices of products, and regulations aimed at regulating prices for accessing knowledge. This is why intellectual property intervention continues to be a major structural issue at the core of the climate change negotiations: there is not enough money, even were there political will, to provide all the public financial support that developing countries need to take action to address climate change mitigation and action.

There is a long-running and ongoing debate on the ways in which developing countries should best ensure their broader economic development.[60] Reflecting this debate is the recommendation for developing countries to transform their economies to become more open to investment, have better, more predictable legal structures, be more open to trade, and provide more room for the private sector. To a significant extent, these are exactly the same policy prescriptions that have been given to developing countries by multilateral financing and development institutions for much of the past three decades. It is an ongoing debate about which economic model is best suited to ensure development and reflects the broader

[59] N. Niziramasanga, "Implementing NAMAs under a New Climate Agreement That Supports Development in Southern Africa" in Karen Holm Olsen, Jargen Fenhann and Søren Lütken, *Elements of a New Climate Agreement by 2015* (Roskilde: UNEP Risoe, 2013).

[60] E.g. E. Helpman, *The Mystery of Economic Growth* (Cambridge: Belknap Press of Harvard University Press, 2004).

development challenge for developing countries. In that sense, it is only realistic to realise that climate change is indeed congruent with the broader development challenge. The paucity of direct public funding for climate change essentially throws developing countries back into the broader set of policy choices regarding how best to ensure economic development more broadly. In the technology arena, this therefore involves asking what are the best ways for countries to ensure that they can move up the technology value chain,[61] what tools have been historically successful for other countries, and are those tools available to developing countries today? This then is the structural reason why intellectual property becomes such an important issue in the climate change debate and why financial support is insufficient as a solution to what is fundamentally the problem of a technology market unsuited to the climate or development challenge.

This article does not aim to discuss what the solutions to this predicament should be.[62] However, clarity as to the nature of the challenge is crucial for any reasonable set of answers and it may be that a certain complacency regarding whether climate change requires any change in the international intellectual property framework has set in. What seems clear is that tinkering around the edges of the system is an insufficient response. More energy on the part of intellectual property policymakers needs to be devoted to addressing this fundamental challenge to the functioning, and in the end the legitimacy, of the intellectual property system as a development tool in the age of climate change.

[61] A.N. Agarwala and S.P. Singh (eds) *The Economics of Underdevelopment* (Oxford: Oxford University Press, 1979); Helpman, *The Mystery of Economic Growth* (2004); A. Santos-Paulino and G. Wan (eds), *Southern Engines of Global Growth* (Oxford: Oxford University Press, 2010); W.W. Rostow, *The Stages of Economic Growth: A Non-Communist Manifesto* (Cambridge: Cambridge University Press, 1990); M. Trebilcock and M. Mota Prado, *What Makes Poor Countries Poor? Institutional Determinants of Development* (London: Edward Elgar, 2011); R. Prebisch, "The Role of Commercial Policies in Underdeveloped Countries" (1959) 49 Am. Econ. Rev. 251.

[62] Matthew Rimmer presents some key proposals that have been under discussion in various fora in his chapter: Matthew Rimmer, "Intellectual Property and Global Warming: Fossil Fuels and Climate Justice" in Matthew David and Debora Halbert (eds), *The SAGE Handbook of Intellectual Property* (London: Sage Publications, 2014), pp.727–753.